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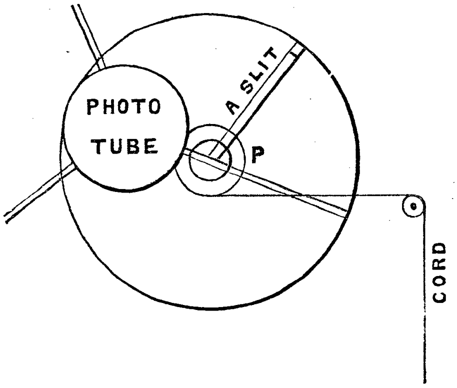
upon an arm two inches outside the mouth of plate-holder tube—so that the radial slit will traverse just in front of the photo-apparatus in same place as the Moon shutter now is. The rotation of the disk will be done by a cord and weight wound half-a-turn around a small pulley on the axis of the disk, the cord being led down to the eye-end by small guide pulleys.

In setting the shutter, the disk is turned till the slit is in position; shown when the cord is wound half-a-turn on the pulley P and the disk held by a detent; on detaching the detent, the disk rotates, carrying the slit across the photo-apparatus, where it is caught by the detent falling into another notch.

The cord passes its dead point and a little beyond it, by the momentum of the disk, and winds up the weight slightly the contrary way; and it is thought that a moderately uniform motion of the slit across the plate-holder may be got in this way. I hope to be able to report our success with this arrangement to you by the next mail.



*Melbourne,*
1874, *October* 7.

## *On Personality in observing Transits of the First and Second Limbs of the Sun.* By E. Dunkin, Esq.

In the *Monthly Notices*, vol. xxix. pp. 259–268, a short paper of mine is inserted, the object of which was to draw the attention of astronomers to a well-marked personality exhibited in the observations of the first and second limbs of the Moon, and to the fact that this personality in the case of some of the observers amounts to a very important quantity. These personal differences are detected in the tabular errors of R.A. of the Moon, determined both from the meridional and extra-meridional observations, and the steadiness of the results from year to year is a decided proof of the reality of the personality.

This question has again come before the Society, bearing upon

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the determination of the longitudes of the stations at which the transit of *Venus* has been observed, and a statement was made at the meeting held on November 13, on the authority of Prof. Asaph Hall, that in the determination of the longitudes from observations of the Moon and Moon-culminating stars, the resulting longitude may be affected by a residual error equal in some cases to four seconds of time, owing to the personal discordances introduced by the different methods of estimation employed by the opposite observers during the transit of the Moon's limbs. This opinion was formed by Prof. Hall from a comparison of the final results of certain well-known determinations of longitude made both by the telegraphic and lunar methods.

Although it seems scarcely possible that so large an error can be outstanding in the resulting longitude by the lunar method, when it depends on a large and *equal* number of observations of the first and second limbs of the Moon, yet it is shown in my comparison of the mean errors of tabular R.A. deduced from the observations on the meridian and with the Altazimuth, that the amount of personality in some observers, different in both limbs, is sufficiently great to account for some of the discordance which has been found between the telegraphic and lunar methods. In the determination of the longitudes of the stations where the transit of *Venus* has been observed, especially of those longitudes which must depend principally upon lunar observations, it is hoped, for this reason, that means will be found to determine the value of the personality in observing the Moon's limbs for each of the observers employed in making the observations from which the longitudes are to be deduced.

In relation to this subject, and to show whether the personality detected in observing the limbs of the Moon is confined to that object, the Astronomer Royal suggested to me that it would be interesting, and at the same time important, to investigate the amount of personal differences between the meridional observations of the first and second limbs of the Sun, as observed at Greenwich by the principal observing assistants, treating the subject in a similar manner to that adopted by me in my former investigation. I had some time ago thought of doing this, but on a casual examination of the errors of the tabular R.A. of the centre of the Sun, and also of the tabular duration of passage, the general smallness of the errors of the tables, positive and negative, made me hastily conclude that there could be no well-marked personality detected out of such small numbers. But I now find that I was labouring under a wrong impression of what could be gathered from a systematic examination.

The numbers, which form the basis of the present investigation may be found in the first pages of the *Planetary Results*, one of the sections in the volume of *Greenwich Observations*. In the reductions it is not usual to compare the observed R.A. of the two limbs of the Sun separately with the tabular R.A. taken from the *Nautical Almanac*, but to take the mean of the two transits, and then to this mean, which represents the clock-time of

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passage of the centre of the Sun, to apply the corrections for the instrumental and clock-errors. To determine the error of tabular R.A. of each limb, the numbers are, however, ready to hand in columns, so that by merely subtracting first the error of observed semi-duration of passage from the tabular error of R.A. of the centre, for the tabular error of R.A. of the first limb, and, secondly, by adding these two quantities together for the tabular error of R.A. of the second limb, we have all that is required. These results are therefore the same as if we had reduced the transit of each limb separately to the end. The numbers being extracted from the printed columns, and separated according to the observer, for each year, and the means of the resulting errors for the two limbs taken, the numbers which are given in Tables I and II are obtained. I may here state that I have confined my inquiry to the ten years included between 1864 and 1873, the former year being that in which M. Le Verrier's Solar Tables were first used in the *Nautical Almanac*.

## Table I.

*Mean Tabular Error in R.A. of Sun from Observations of the First Limb.*

| Year. | Mr. Dunkin. (D.) s | Mr. Ellis. (E.) s | Mr. Criswick. (C.) s | Mr. Lynn. (L.) s | Mr. J. Carpenter. (J. C.) s | Mr. H. Carpenter. (H. C.) s |
|---|---|---|---|---|---|---|
| 1864 | −0·002 | −0·046 | +0·006 | ... | −0·156 | ... |
| 1865 | − ·036 | − ·033 | + ·062 | ... | − ·110 | ... |
| 1866 | − ·037 | − ·136 | + ·007 | ... | − ·135 | +0·001 |
| 1867 | − ·063 | − ·161 | + ·028 | ... | − ·154 | ... |
| 1868 | − ·024 | − ·108 | + ·005 | ... | − ·111 | − ·020 |
| 1869 | − ·018 | − ·063 | + ·021 | ... | − ·125 | + ·042 |
| 1870 | ... | − ·080 | + ·008 | −0·030 | − ·137 | − ·010 |
| 1871 | ... | − ·065 | − ·008 | − ·035 | − ·156 | − ·044 |
| 1872 | ... | − ·138 | − ·024 | + ·033 | − ·165 | − ·098 |
| 1873 | ... | − ·081 | + ·015 | + ·016 | ... | ... |

## Table II.

*Mean Tabular Error in R.A. of Sun from Observations of the Second Limb.*

| Year. | D. s | E. s | C. s | L. s | J. C. s | H. C. s |
|---|---|---|---|---|---|---|
| 1864 | +0·041 | +0·010 | +0·014 | ... | +0·020 | ... |
| 1865 | + ·016 | + 062 | + ·057 | ... | + ·076 | ... |
| 1866 | − ·003 | − ·011 | − ·021 | ... | + ·008 | +0·161 |
| 1867 | + ·014 | − ·037 | + ·086 | ... | + ·019 | ... |
| 1868 | + ·040 | − ·017 | + ·035 | ... | + ·115 | + ·174 |
| 1869 | + ·083 | + ·038 | + ·033 | ... | + ·068 | + ·162 |
| 1870 | ... | + ·016 | + ·053 | +0·077 | + ·056 | + ·194 |
| 1871 | ... | + ·041 | + ·038 | + ·027 | − ·013 | + ·186 |
| 1872 | ... | + ·023 | + ·021 | + ·083 | − ·026 | + ·086 |
| 1873 | ... | + ·024 | + ·020 | + ·096 | ... | ... |

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The next table exhibits the mean tabular error of each observer's group both for the first and second limbs, and also the mean error of the tabular duration of passage of the diameter of the Sun. I also insert the mean tabular error of the centre of the Sun, as deduced from the mean of the separate groups for 1st L. and 2nd L., by using each observer's own value of the mean duration of passage:—

Table III.

| | *Mean Tabular Error in R.A. of Sun.* | | | *Error of Tabular Duration of Passage of Diameter.* |
|---|---|---|---|---|
| | 1st L. | 2nd L. | Centre. | |
| | s | s | s | s |
| D. | −0·030 | +0·032 | +0·001 | +0·062 |
| E. | − ·091 | + ·015 | − ·038 | + ·106 |
| C. | + ·012 | + ·034 | + ·023 | + ·022 |
| L. | − ·004 | + ·071 | + ·034 | + ·075 |
| J. C. | − ·139 | + ·036 | − ·051 | + ·175 |
| H. C. | − ·022 | + ·160 | + ·069 | + ·182 |

In the above table, the differences to be noticed, especially in the errors for the first limb, are too great to be accidental; on the other hand, there can be no doubt of the reality of a well-marked personality in Mr. J. Carpenter's estimation of the first limb, and in Mr. H. Carpenter's estimation of the second limb, while the differences of the numbers generally represent, I believe, the relative differences or habits of all the observers. To show that there is the same method employed in observing the limbs of the Sun and Moon, although the glare produced by the Moon in the field of the telescope is greater than that produced by the Sun, whose light is sufficiently moderated by being viewed through coloured glasses, I place here the differences between the errors of the tabular R.A. of the Sun determined by Mr. Criswick and those of D, E, and J. C, side by side with the corresponding differences of the tabular errors of the R.A. of the Moon extracted from my former paper (vol. xxix. p. 267):—

Table IV.

| | *Tabular Errors of R.A. of Sun.* | | *Tabular Errors of R.A. of Moon.* | | | |
|---|---|---|---|---|---|---|
| | Transit-Circle Obs. | | Transit-Circle Obs. | | Altaz. Obs. | |
| | 1st L. | 2nd L. | 1st L. | 2nd L. | 1st L. | 2nd L. |
| | s | s | s | s | s | s |
| C.−D. | +0·052 | +0·002 | +0·034 | +0·032 | −0·047 | −0·028 |
| C.−E. | + ·103 | + ·019 | + ·112 | + ·077 | + ·104 | + ·048 |
| C.−J.C. | + ·150 | − ·001 | + ·132 | + ·038 | + ·207 | + ·004 |

This comparison gives good evidence that the different habits of observing the limbs of the Sun and Moon by these four observers are essentially the same in the observations of both objects. In

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Tables V and VI which follow, the numbers represent the comparison of the tabular errors of the first and second limbs of the Sun from each observer's annual mean in Tables I and II, referred to the corresponding tabular errors from the annual mean of Mr. Criswick's observations. The steadiness of the personality is very clearly shown.

### TABLE V.

*Comparison of the Tabular Error of R.A. of Sun determined by each Observer, referred to Mr. Criswick as the Standard, from Observations of the First Limb.*

| Year. | C.−D.<br>s | C.−E.<br>s | C.−L.<br>s | C.−J.C.<br>s | C.−H.C.<br>s |
|---|---|---|---|---|---|
| 1864 | +0·008 | +0·052 | ... | +0·162 | ... |
| 1865 | + ·098 | + ·095 | ... | + ·172 | ... |
| 1866 | + ·044 | + ·143 | ... | + ·142 | +0·006 |
| 1867 | + ·091 | + ·189 | ... | + ·182 | ... |
| 1868 | + ·029 | + ·113 | ... | + ·116 | + ·025 |
| 1869 | + ·039 | + ·084 | ... | + ·146 | − ·021 |
| 1870 | ... | + ·088 | +0·038 | + ·145 | + ·018 |
| 1871 | ... | + ·057 | + ·027 | + ·148 | + ·036 |
| 1872 | ... | + ·114 | − ·057 | + ·141 | + ·074 |
| 1873 | ... | + ·096 | − ·001 | ... | ... |
| Means | +0·052 | +0·103 | +0·002 | +0·150 | +0·023 |

### TABLE VI.

*Comparison of the Tabular Error of R.A. of Sun, determined by each Observer, referred to Mr. Criswick as the Standard, from Observations of the Second Limb.*

| Year. | C.−D.<br>s | C.−E.<br>s | C.−L.<br>s | C.−J. C.<br>s | C.−H. C.<br>s |
|---|---|---|---|---|---|
| 1864 | −0·027 | +0·004 | ... | −0·006 | ... |
| 1865 | + ·041 | − ·005 | ... | − ·019 | ... |
| 1866 | − ·018 | − ·010 | ... | − ·029 | −0·182 |
| 1867 | + ·072 | + ·123 | ... | + ·067 | ... |
| 1868 | − ·005 | + ·052 | ... | − ·080 | − ·139 |
| 1869 | − ·050 | − ·005 | ... | − ·035 | − ·129 |
| 1870 | ... | + ·037 | −0·024 | − ·003 | − ·141 |
| 1871 | ... | − ·003 | + ·011 | + ·051 | − ·148 |
| 1872 | ... | − ·002 | − ·062 | + ·047 | − ·065 |
| 1873 | ... | − ·004 | − ·076 | ... | ... |
| Means | +0·002 | +0·019 | −0·038 | −0·001 | −0·134 |

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These tables, perhaps more than in any of the preceding, exhibit clearly to the eye the remarkable differences between C and J. C in Table V, and between C and H. C in Table VI. There is, therefore, this curious fact, that whereas Mr. J. Carpenter's personality lies almost wholly in observations of the first limb, Mr. H. Carpenter's personality lies almost wholly in observations of the second limb. The effect of these peculiar personal habits of estimation of the solar limbs is that the position of the centre of the Sun, according to the two observers, differs $0^s{\cdot}12$, or nearly two seconds of arc.

As the numbers in the preceding tables show that the errors of the R.A. of the Sun and Moon, deduced from observations made with the Transit-circle by D, E, C, and J. C, are larger for the first limb than for the second limb, and that there is a general resemblance in the magnitude of the differences between the results of the separate observers for both objects, it may be assumed that the personalities detected by the present and former comparisons are as real as those which have been so long known in connection with transits of stars. Having a knowledge of this fact, which, I believe is the chief cause of the discrepancy found between the resulting longitudes determined by the telegraphic and lunar methods, all future standard determinations of longitude by the lunar method should be corrected for any personality in observing the Moon's limb, such as I have exhibited in this paper as existing in the case of observers who have had such great experience in this class of observation.

In preparing the tables which are given above, I included originally the observations made by several occasional observers. They were, however, comparatively so few in number, that I resolved to confine myself to those of the principal assistants, with the addition of Mr. H. Carpenter, whose observations have extended over several years. So far, however, as I could judge from the limited number of observations of the junior observers, the same decided personalities are visible, and in amount fully equal to any contained in this present paper. I have also not included Mr. Downing's one year's observations, in 1873, in the tables, but they show that his personality exists in transits of the second limb, the respective tabular errors of R.A. being $-0^s{\cdot}027$ and $+0^s{\cdot}143$.

I am not able to point out, or even to suggest, any cause for these peculiar habits of observing the limbs of the Sun and Moon, except that they may possibly arise from the different personal methods of estimating by the eye the positions of the two limbs in transit, as affected by irradiation. Most observers, however, have an impression that transits of the first limb are not so easily made as those of the second limb; owing in some measure to the first effect of the glare on the eye, which causes the transit-wires to appear fainter in the former observations than when the second limb is approaching, when the wires are seen projected as black lines on a luminous background. That

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the personality has its origin in the eye is most probable, as in all the observations used in this investigation the transits were recorded automatically on the chronograph.*

*Kenwyn, Kidbrooke Park Road,*
*Blackheath,* 1874, *Dec.* 10.

* Dr. Robinson has remarked, in the Introduction to the *Armagh Catalogue*, on the existence of a variable personal equation in observing transits of the first and second limbs of the Moon, and he has given examples of the effect of this personality, by comparing the difference of longitude, determined by the method of Moon-culminating stars, between Armagh and the Observatories of Greenwich, Dublin, Cambridge, Königsberg, and Paris, as found from observations of the first and second limbs of the Moon. His discordances between the separate results are great, but the number of observations is generally far too small to obtain a trustworthy determination. Dr. Robinson concludes that these personal differences are owing solely to irradiation, the origin of which is in the eye. He has, from experiment, found that the irradiation of the limb is diminished considerably by strongly illuminating the field of view; and, by reducing the aperture of the object-glass by a semi-transparent diaphragm of oiled paper, which should fill the field with scattered light, he has very largely reduced the error in the Sun's observed diameter produced by irradiation.

## *Phenomena of Jupiter's Satellites, observed at Mr. E. Crossley's Observatory, Bermerside, Halifax, with a $9\frac{1}{3}$-inch Equatoreal Refractor by Cooke.*

### By Mr. Joseph Gledhill, F.R.A.S., F.G.S. etc.

| Date. 1873. | Satellite. | Phenomenon. | G.M.T. h | m | s | Remarks. |
|---|---|---|---|---|---|---|
| May 6 | I. | Sh. I. int. contact | 8 | 32 | 20 | Considerable motion; not a good obs. |
| | | Tr. E. int. contact | 9 | 31 | 3·5 | Bad definition; not good observations. |
| | | bisection | 9 | 33 | 2·3 | |
| | | ext. contact | 9 | 34 | 30 | |
| May 9 | II. | Tr. I. ext. contact | 8 | 57 | 0·5 | The first and last are the best. |
| | | bisection | 8 | 59 | 30·4 | |
| | | int. contact | 9 | 1 | 0·8 | |
| May 11 | II. | Ec. R. first seen | 9 | 29 | 6·2 | Good. |
| | | fully bright | 9 | 31 | 0 | Pretty good. |
| May 12 | I. | Occ. D. | 11 | 49 | 0 | Quite gone; cloud prevented a good view. |
| May 13 | I. | Tr. I. ext. contact | 9 | 9 | 0 | Good. |
| | | bisection | 9 | 11 | 3·5 | Pretty fair. |
| | | int. contact | 9 | 12 | 6·3 | Good. |
| | I. | Sh. I. int. contact | 10 | 28 | 4 | Pretty fair observation. |
| | I. | Tr. E. ext. contact | 11 | 30 | 30 | Planet low; definition bad. |
| May 14 | I. | Ec. R. first seen | 9 | 51 | 15·5 | Good. |
| | | fully bright | 9 | 53 | 5 | Fair. |